

Low atmospheric pO_2 in the aftermath of the oldest Paleoproterozoic glaciation

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The rise of the atmospheric pO_2 and the occurrence of Paleoproterozoic glaciations may be related via oxidation of atmospheric methane and subsequent collapse of greenhouse conditions (Pavlov et al., 2000). A lack of a significant mass independent signal in S isotopes of sulfides from the shales both underlying and overlying the first tillite of the Huronian Supergroup (Wing et al., 2004) supports this interpretation and provides a constraint on the minimum atmospheric pO_2 . However, constraints for the maximum atmospheric pO_2 and its variations during the Paleoproterozoic glacial epoch are lacking.

Here we report S isotope values of pyrites in conglomerates of the siliciclastic Mississagi Formation, 2.45-2.22 Ga Huronian Supergroup that were deposited between the first and second glaciations. Pyrite grains have a range of 10 ‰ in $\delta^{34}S$ and a 1.5 ‰ variation in $\Delta^{33}S$ on the scale of hand samples. Conglomerates with pyrite grains occur in the entire Huronian Basin, indicating regional distribution of pyriiferous facies in mature sediments.

The sulfur isotope data are consistent with the detrital origin of the pyrites from conglomerates with their source in Archean greenstone belts and imply low atmospheric pO_2 limiting oxidative pyrite dissolution. In contrast, S and Fe isotope values of pyrites in black shales deposited after the second Paleoproterozoic glaciation in South Africa indicate oxidative sulfide weathering and a redox-stratified ocean (Bekker et al., 2004; Rouxel et al., 2005). The emerging picture is that a stepwise increase in the atmospheric pO_2 throughout the Paleoproterozoic glacial epoch was accompanied by a decrease in the atmospheric pCH_4 and an increase in the atmospheric pCO_2 .